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Effects on Eastern Larch Beetle of Its Natural Attractant and Synthetic Pheromones in Alaska

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Abstract

Traps baited with Seudenol + α-pinene caught 87 percent more eastern larch beetles, Dendroctonus simplex LeConte, than did tamarack logs infested with females. Male beetles responded to the synthetic attractant in greater numbers than females. Male beetles were not attracted to frontalin, a principal attractant of the closely related Douglas-fir beetle, Dendroctonus pseudotsugae Hopkins. Attraction was reduced by 92 and 86 percent by addition of methylcylohexenone (MCH) and frontalin but by only 36 percent when trans-verbenol was added. This evidence partially supports the taxonomic separation of the two Dendroctonus species.

Keywords: Attractants (chemical) (-forest pest control, eastern larch beetle, Dendroctonus simplex.

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Introduction

The eastern larch beetle, Dendroctonus simplex LeConte, is a primary pest of tamarack, Larix laricina (DuRoi) K. Koch, in western Canada and Alaska. Beetles normally attack tamarack stands that have been weakened, in some instances by defoliation during outbreaks of the larch sawfly, Pristiphora erichsonii (Hartig), or larch budmoth, Zeiraphera improbana (Walker). The beetles readily attack green, healthy tamarack when the parent population increases above the carrying capacity of the initially attacked trees. Infested trees seldom survive.

The presence of unmated females in a recently attacked tree intensifies the attractiveness of the host tree to male beetles. Although no aggregative pheromones have been isolated from D. simplex females, experiments have shown that males are attracted to female-infested bolts and to Seudenol (3-methyl-2-cyclohexen-1-ol) (Baker et al. 1977). Seudenol (Vite' et al. 1972), frontalin (Kinzer et al. 1971), and trans-verbenol (Rudinsky et al. 1972) have been identified as aggregative pheromones of the Douglas-fir beetle, D. pseudotsugae Hopkins. In addition, methylcyclohexenone (MCH) was identified as an anti-aggregative pheromone in D. pseudotsugae (Kinzer et al. 1971). D. simplex and D. pseudotsugae are taxonomically similar (Wood 1963, Furniss 1976) and could produce similar aggregative and anti-aggregative pheromones. A field test was conducted to assess the effect of frontalin, MCH, and trans-verbenol on the natural attractant of D. simplex.

Methods

A field test was conducted for 6 days in June 1978 in an 80-yr-old open tamarack stand on the Bonanza Creek Experimental Forest 42 km west of Fairbanks, Alaska. Tree height varied from 1.8 to 9.0 m with d.b.h. between 2.5 and 15.0 cm. Temperatures ranged from 2° to 27°C during the test.

Cylindrical sticky traps similar to those described by Kline et al. (1974) were baited with the test materials. The traps were set on iron posts 1.5 m above the ground at 30-m intervals. The traps measured 45 cm in length, 25 cm in diameter, and were constructed of 6.35-mm mesh wire screen. Two replications of 23 traps each were used in a randomized complete block design. Twenty-three treatments were assigned to the traps each day for 6 days in a randomized manner. Days were treated as subsamples, and the 6-day data were pooled for each treatment per replicate. In addition, the test site of each replication was moved a distance of at least 60 m to a new location in order to eliminate the effects of spillover of beetles from the attractant-baited traps into adjacent live tamarack trees, thus creating an additional attractive source.

Treatments consisted of tamarack logs infested with females and the synthetic pheromones: Seudenol, frontalin, trans-verbenol, and MCH, alone and in combination with each other as shown in table 1. Controls consisted of an empty trap and an uninfested log section. The sources of natural attractant were tamarack log sections, ca. 9 cm in length and 9 cm in diameter, artificially infested by unmated female beetles. Freshly cut tamarack logs were infested in the laboratory 1 day before testing.

Part of the experiment utilized tamarack logs infested with unmated D. pseudotsugae females transported to Alaska from Idaho. The attractants produced by D. pseudotsugae were tested to determine if D. simplex responded to a taxonomically similar species. These beetles were stored for 1 week at 5°C and then placed at 22°C for 2 days before infesting the logs. D. simplex female beetles were treated similarly. One female beetle was placed in each of five preformed entrance holes in each log; i.e., five female beetles per log, the holes were covered with metal screen, and the log enclosed in a metal screen cage to exclude wild male beetles because mating would terminate the production of attractants by the females in the infested logs.

The synthetic pheromones were 1 ml each of Seudenol, frontalin, trans-verbenol and MCH in open 1/2-dram glass vials placed within perforated aluminum cans attached to the traps. Alpha pinene in 1-ml quantities was used as a synergist to Seudenol.

Table 1--Number of *Dendroctonus simplex* adults trapped in response to natural and synthetic pheromones

Treatments	Mean catch/day			Daily range	
	♀	♂	Σ	♀	♂
Seudenol + α-pinene	12.0 d[1]/	30.1 b	42.1 a	3-35	3-93
Seudenol + α-pinene + TV[2]/	6.3 de	20.9 c	27.2 bc	1-17	4-62
5 *D. simplex* log	5.2 de	2.0 e	7.2 de	1-16	0-8
Seudenol + α-pinene + F[3]/	3.4 e	2.6 e	6.0 de	0-7	0-5
α-pinene	3.5 e	2.3 e	5.8 de	0-4	0-6
5 *D. pseudotsugae* log	2.8 e	1.5 e	4.3 e	0-15	0-12
Seudenol + α-pinene + MCH[4]/	2.4 e	1.1 e	3.5 e	0-16	0-4
5 *D. simplex* log + TV	2.0 e	1.3 e	3.3 e	0-11	0-4
Untreated log	1.6 e	1.0 e	2.6 e	0-13	0-7
Seudenol + α-pinene + TV + F	1.3 e	1.2 e	2.5 e	0-5	0-3
Seudenol + α-pinene + MCH + TV	1.5 e	0.9 e	2.4 e	0-6	0-6
Seudenol + α-pinene + MCH + TV + F	1.0 e	0.4 e	1.4 e	0-3	0-4
5 *D. simplex* log + MCH + TV	0.8 e	0.5 e	1.3 e	0-7	0-4
Seudenol + α-pinene + MCH + F	0.5 e	0.6 e	1.1 e	0-5	0-3
5 *D. simplex* log + MCH	0.6 e	0.4 e	1.0 e	0-1	0-2
5 *D. simplex* log + F	0.2 e	0.3 e	0.5 e	0-6	0-3
TV + α-pinene	0.2 e	0.2 e	0.4 e	0-2	0-2
Untreated trap	0.2 e	0.2 e	0.4 e	0-1	0-2
F + α-pinene	0.1 e	0.1 e	0.2 e	0-1	0-1
MCH	0.1 e	0.1 e	0.2 e	0-1	0-1
TV + MCH	0.1 e	0.1 e	0.2 e	0-1	0-1
F + MCH	0.1 e	0.0 e	0.1 e	0-1	0
F + MCH + TV	0.0 e	0.1 e	0.1 e	0	0-1
F + TV	0.0 e	0.0 e	0.0 e	0	0

[1]/Values followed by the same letter within each test are not significantly different at the 5-percent level (Duncan's New Multiple Range Test).
[2]/TV = *trans*-verbenol
[3]/F = frontalin
[4]/MCH = methlycyclohexenone

The commercial preparations of synthetic pheromones were purified by preparatory gas-liquid chromatography (Birch et al. 1977) to >99.8 percent using 4-percent Carbowax 20 M on Chromsorb G (60/80 mesh) in a 6-m X 6.3-mm glass column.

Results and Discussion

The catches of D. simplex adults by treatment are shown in table 1. Response by D. simplex shows that some treatments were attractive but others repressed attraction. Seudenol + α-pinene caught 505 beetles or 40 percent of the total catch (1,273 beetles). The next best catch was Seudenol + α-pinene + trans-verbenol with 327 beetles or 26 percent of the total catch. Logs with D. simplex females caught only 7 percent of the beetles.

The untreated log, α-pinene alone, and in combination with either frontalin or trans-verbenol were not attractive to either male or female beetles. Renwick (1970) has hypothesized that trans-verbenol enhances the attraction of those Dendroctonus species that are attracted to pinene because it is similar chemically. The fact that both α-pinene and trans-verbenol were not attractive to D. simplex supports this hypothesis.

The logs containing D. simplex females caught 39 percent more beetles than logs with D. pseudotsugae females. The reason for the difference in attractiveness between taxonomically similar Dendroctonus species could be the production of frontalin by D. pseudotsugae females which in our study actually repressed attraction. Possibly D. simplex uses a different combination of pheromones than D. pseudotsugae.

The addition of trans-verbenol, frontalin, and MCH either separately or in combinations to Seudenol + α-pinene significantly repressed attraction by D. simplex adults. The addition of MCH to Seudenol + α-pinene depressed response of D. simplex by 92 percent whereas the addition of frontalin alone and trans-verbenol alone depressed response by 86 and 36 percent respectively. D. simplex response was further depressed (97 percent) when MCH, trans-verbenol and frontalin were all combined with Seudenol + α-pinene. Reduced catches were also reported for D. pseudotsugae when MCH and trans-verbenol were added to frontalin (Rudinsky et al. 1972).

The frontalin + α-pinene and frontalin + untreated log were the only treatments which caught (eight specimens) the bark beetle predator, Thanasimus dubius (L.). Orthotomicus caelatus Eichoff and Pityopthorus opaculus LeConte were the only other scolytids caught. Most O. caelatus were caught on the ♀ D. simplex-baited traps while most P. opaculus was caught on the ♀ D. pseudotsugae log (ID), the untreated control log, and the frontalin + untreated log.

Conclusions

Combinations of synthetic attractants caught more *D. simplex* beetles than the beetle's natural attractant. Seudenol + α-pinene caught significantly more beetles than female-infested tamarack logs. The addition of MCH and frontalin to Seudenol + α-pinene significantly repressed attraction. The addition of *trans*-verbenol to Seudenol + α-pinene repressed attraction to a much lesser amount than MCH and frontalin.

The results of this field study add support to the taxonomic differences that tend to separate *D. simplex* and *D. pseudotsugae*. *D. simplex* was not attracted to frontalin, which is a principal component of the aggregation system of *D. pseudotsugae*.

The pheromone components used in the aggregation system of *D. simplex* should be isolated and identified in order to further study the feasibility of using MCH or frontalin for controlling small isolated infestations of *D. simplex*.

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